Mango biodiversity in eastern Uttar Pradesh, India: Indigenous knowledge and traditional products

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The patterns of nomenclature, conservation and traditional uses of mango (*Mangifera indica* L.) trees and fruits were studied in four districts of eastern Uttar Pradesh (Jaunpur, Azamgarh, Sultanpur and Faizabad), which have preponderance of mango groves consisting of landraces. An explanatory (qualitative) research design, supported by participatory research tools, was adopted to collect the data. The study specifically focused on the role of Indigenous knowledge in the sustainable management of mango groves, which have played a crucial role in livelihood adaptations in the past. It emerged from the data that present day mango groves were planted by the forefathers of present generations who believed in the philosophy of "*aadhi kheti, aadhi baari*" which literally means '*half the crop lands and half the gardens'*. This philosophy, based on premise that half the area of a village ecosystems should be cultivated to produce food grains while another half should be under tree plantations to ensure provisioning of fruits, fuel wood, timber and environmental services, was driven by an integrated and sustainable farming approach based on local resources and traditional knowledge.

Keywords: Mango landraces, Indigenous knowledge, location specific adaptation, traditional mango products

Introduction

Mango (*Mangifera indica* L.; Anacardiaceae) is the most widely cultivated fruit crop of India and reportedly there are over 1,000 varieties found in the country[1]. It is one of the choicest fruits of the country and has a long history of cultivation. Mango has been mentioned in ancient Vedic texts as well as in notes of foreign travelers. The fact that Mughal emperors promoted cultivation of the best mango varieties and planted many large orchards is an enduring testimony to the tremendous value of mango in Indian society and culture[2]. Many of the commercial mango varieties emerged as chance seedlings during Mughal rule[3]. Available records indicate that Indian people had accumulated substantial knowledge on mango culture by 16th century A.D. or even earlier[2]. The mango tree and its different parts are deeply embedded in Indian art and tradition and have been an integral part of Indian cultural heritage from time immemorial. Mango is grown in almost all the states of India and Uttar Pradesh is one of the leading producers. Many of the choicest mango varieties have originated in this state, which produces over 20% of the total mangoes in India. Thanks to the rich genetic wealth of mangoes in Uttar Pradesh, the overall fruit harvest extends for over three months, from mid May to end of August[4]. Indigenous knowledge, also referred to as traditional ecological knowledge (TEK), has been acquired through close interaction and informal experimentation with nature and is crucial to natural resource management and sustainable livelihoods of local communities

worldwide. From time immemorial, Indian farmers, particularly those living under fragile and marginal environments, have developed climate-resilient farming systems and adaptive management approaches for their natural resources through location specific TEK[5]. In Asia, tropical fruits play an important role in people's livelihoods and food security. They not only produce fruit for consumption and add value to local crops, but also lend livelihood support in terms of household income, employment generation, timber production, livestock fodder, medicinal products and environmental services[6]. Among the many tropical fruits, mango has been identified as the most important, culturally, commercially and environmentally[6]. In this backdrop, this research attempts to shed light on the role of mango landraces in livelihood adaptation and cultural traditions of the peoples of eastern Uttar Pradesh, India from a biocultural perspective.

Research methodology

Study area

This study was conducted in Jaunpur, Azamgarh, Sultanpur and Faizabad districts of eastern Uttar Pradesh in years 2013 and 2014. Based on rainfall, terrain and soil characteristics, nine agroclimatic zones have been recognized in the state of Uttar Pradesh: Tarai, Western Plain, Central Western Plain, South Western Semi Arid, Central Plain, Bundelkahnd, North Eastern Plain, Eastern Plain and Vindhyan hills[7]. The study districts lie in the Eastern Plain zone of the state, which has a subtropical climate with wide variations in mean summer (41.4 ºC) and winter (5.7 ºC) temperatures[8]. The soils in the region are alluvial and salt-affected with a predominance of moderately to strongly saline-sodic lands having excessive concentrations of either soluble salts or exchangeable sodium or both[9,10]. A rice-wheat cropping system predominates in the region [7].

Method of data collection

To document the qualitative data on mango grove management, traditional knowledge of nomenclature, use of fruits for making traditional products and *in situ* conservation, an explanatory research design was adopted. This approach was used to better understand the dynamics of tree management and fruit harvesting from a sustainable resource use perspective[5]. Using a multistage sampling, Sikrara, Jahanaganj, Motigarpur and Masaudha developmental blocks of Jaunpur, Azamgarh, Sultanpur and Faizabad districts, respectively, were selected. In the next stage, one study village from each of the selected developmental blocks (village Banki from Sikrara, Sonapur from Jahanaganj, Nanemau from Motigarpur and Bhadokhar from Masaudha) was randomly selected. A systematic sampling procedure[5] was applied to select mango tree owners and other stakeholders for collecting the data. A total of 60 key knowledge holders (46 to 72 years in age; 40 men and 20 women) were interviewed to document their observations and experiences relating to mango. The criterion followed in selecting the key knowledge holders was that each respondent must have at least 20 years of active association with mango tree management and use. Both personal interviews and participatory rural appraisal (PRA) methods were applied to obtain the data. Interviews were conducted with sampled respondents using a semi-structured interview schedule with open-ended questions. The women respondents were mostly asked questions related to traditional mango

products- ingredients used, methods of preparation and the specific nutritive and ethnomedicinal properties of these products. In addition to key knowledge holders, young (15 to 30 years) and middle aged (31 to 45 years) persons (three from both age groups from each village) were also selected to assess potential intergenerational gaps in traditional knowledge of different aspects of mango trees and traditional products. The interview schedule was pilot tested and refinement in questions was made. The traditional knowledge of respondents was measured on a four point continuum: '3' for full knowledge; '2' for moderate knowledge; '1' for least knowledge; and '0' for no knowledge. The inventory required for measuring traditional knowledge of young, middle-aged and old-aged respondents was developed in each village through focus group discussions (FGD). Based on the commonality of a particular aspect, indicators of mango knowledge were developed and asked to each respondent. Significance of knowledge relating to different aspects was tested applying a 'Z' test with the help of SPSS packages (Version 17). The prior informed consent was obtained from the knowledge holders to report their knowledge and practices.

Results and discussion

Site selection, planting and care

A strong majority (82%) of the respondents opined that new mango groves were planted in well drained, fertile soils (often sandy loam in texture as opined by 68 % of them) mostly located at walking distance from human settlements. Those sites which lacked irrigation facilities and would otherwise be left uncultivated were preferred to raise the new trees. Sodic soils were neither cultivated to produce food grains nor to raise mango trees. Occasionally, planting was also done in elevated lands (locally called *Bhita*) in the vicinity of ponds. In local *Awadhi* and *Bhojpuri* dialects of Hindi, these ponds are called *pokhra* and *pokhri* for their respective large and small sizes. These water bodies were the sources of irrigation water in early years of mango tree establishment. The mango seedlings were mostly planted during the rainy season, about 8-10 metres apart. The newly planted trees were paid due care, with special emphasis on irrigation during summer months, during the initial 3-4 years of establishment. After attaining about 6 feet height, the trees were not paid any special care and were left at the mercy of God. As revealed by 26 % of the elder respondents (above 60 years in age), majority of the existing mango groves in study districts were raised by their forefathers who believed in the philosophy of '*aadhi kheti, aadhi baari*'. This philosophy, based on premise that half the area of a village ecosystems should be cultivated to produce food grains while another half should be under tree plantations to ensure provisioning of fruits, fuel wood, timber and environmental services, was driven by an integrated and sustainable farming approach.

The planting and care of mango groves by past generations in study districts signified a strong cultural tradition for adaptive management of natural resources for environmental integrity and food security and it justifies the observation that Indigenous knowledge holds enormous practical utility for sustainable agro-ecosystem management and conservation strategies[11]. The forgotten people of the past applied their TEK to sustainably utilize the unproductive lands by raising the mango trees. Indigenous systems of tree management not only resolve social

conflicts but are also helpful in expanding the area under tree cover. The contributions of local peoples towards sustainable natural resource management have been recognized[12].

Nomenclature of the landraces

The mango landraces in study districts are named in local *Bhojpuri* and *Awadhi* dialects and each local name connotes a specific meaning. A majority (76 %) of the respondents agreed that new mango trees are usually named after fruit quality attributes, time of ripening, tree shape, bearing habit and some other characteristics. The majority of the landraces describe important fruit quality traits such as: fruit shape [*Khirahava* (cucumber shaped), *Belauva* (*bael* fruit shaped), *Aluvahava* (potato shaped), *Golahava* (round fruits), *Lodhiyahava* (long, slender fruits)]; fruit taste [*Cheeniyahava* (very sweet), *Mithauva* (very sweet), *Amilahava* (very sour), *Kharbujahava* (similar to muskmelon), *Kerava* (similar to banana), *Dahiyahava* (similar to curd)]; and fruit colour [*Sindurahava* (vermillion blush on ripe fruits), *Kajarahava* (kohl tinge on fruits)]. New trees have also been named according to season of ripening [*Bhadauva* (ripening in *Bhadrapad* month), *Ashadhihava* (ripening in *Ashadh* month)]; bearing habit [*Jhabrahava*/*Jhoppahava* (cluster bearing)]; tree size/shape [*Langra* (bending/curving tree trunk), *Satpedava* (a single tree consisting of seven trunks bearing different quality fruits), *Jadupatti* (gigantic tree, about 3 times of usual size); and other characteristics such as thin fruit skin (*Kagazahava*), paper thin seed stone (*Seepiyahava*), heavy infestation of red ants (*Matahava*), and heavy latex exudation from fruits (*Chopiyahava*).

The mango landraces in the study districts, well adapted to existing agro-edaphic conditions, have been selected, planted, named and maintained by the local peoples to meet their diverse socio-cultural needs. The local names of mango landraces not only describe important fruit and tree characteristics but also provide a major criterion for tree identification by the owners. The mango landraces in Indian states of Punjab[14] and Gujarat[15] are also named in local languages. In other mango growing countries such as Kenya[13] and Nepal[16] local mango trees are named in the native languages. In *tarai* region of neighbouring Nepal, naming of mango landraces in local language is based on various tree (such as leaf shape, canopy shape and tree size) and fruit (such as size, colour, shape, taste and aroma) characteristics[16].

Role in food security

According to a majority (68%) of the respondents, the main reasons behind the plantings of mango groves by their ancestors' were social prestige, environmental integrity and the need to ensure availability of mango fruits to alleviate food insecurity. In pre-Green Revolution days, scarcity of food products was very common in study districts particularly in the summer months. Under these circumstances, ripe mango fruits filled major gaps in food supply. The collection and consumption of ripe mango fruits and different traditional products significantly improved the livelihoods of local peoples. An outsider to the family/clan was not allowed to harvest and/or collect the fallen fruits. Once the fruits have ripened, the family members would watch the trees in night to avoid any unauthorized theft. The mangoes were often ripened in bulk- a practice locally called *pal dalna*- to serve the fruits to guests and relatives during marriages and other functions. The fruits ripened this way were also send to those

relatives who did not own the mango trees. It may seem an exaggeration but many a man would carry *roti* (wheat bread) with him and eat the same with juicy mangoes sitting beneath the trees. Diverse types of landraces planted in mango groves provided a staggered harvest window for over two months. After the fruiting season was over, the chutney prepared from *amawat* (a traditional product made from ripe fruits) was eaten with bread.

It is assumed that local peoples in the study districts had a limited resource base to satisfy their livelihood requirements and this would have compelled them to conserve and enhance mango tree diversity through Indigenous knowledge and landscape manipulations. The planting of mango trees was deliberately done in such lands without permanent irrigation facilities and otherwise would have been left unproductive. In the context of widespread agrarian distress in rural India today, finding ways to secure livelihood sustainability of small farmers has become an urgent concern. Indigenous fruits play an important role in the food and nutritional security of local peoples in different parts of the world[17]. One of the major findings of this study was that ripe mango fruits have played a great role in alleviating the problem of food shortages in the study region. In addition, different traditional mango products have been instrumental in maintaining dietary diversity of the mango tree owners and their families. With passage of time, however, the unique place of mango fruits in local diets had witnessed a steady decline. This may be attributed to continued expansion under irrigated area after 1970s that enabled people to grow more food crops.

Traditional mango products

Besides their general use for fresh consumption (mainly sucking), mango fruits have been traditionally processed into different value-added products. Most of these are prepared from mature, unripe fruits. They include *achar, amchur, aam ka chhilka, chutney, gurmitthi, sirka, aam ka pana, shakkar amba, khatai, galka and gulamma*. The ripe fruits are made into a delicacy locally called *amawat*. *Aam ka pana*, a refreshing drink used in the summer months, is also made and sold by the local vendors in towns and cities. The preparation of these products in the home is almost exclusive responsibility of women. The ingredients, methods of preparation and the nutritive and ethnomedicinal properties of these products are given in Table 1. Pictures of some of the traditional mango products are shown in Fig. 1.

The traditional knowledge of value addition in mango by the women folk in study districts is remarkable. As stated by a majority (73%) of the women respondents, they have learned the art of preparing different mango products from their women family elders. A small proportion (27%) of our interviewees acquired their expertise in processing and value addition of mangoes by learning and doing and through informal experimentation while working with their peers. These findings highlight the continuity of knowledge transmission between the past and present generations. The value-added mango products have played, and still do play, a key role in the local food economy. Local peoples have designed sustainable mango-based food systems for their household needs. Rural women have been using simple and traditional methods to prepare a variety of traditional mango products. These

low-cost traditional methods are based on Indigenous knowledge and are adapted to the local culture and environment.

Conservation of landraces

As previously mentioned, most of the existing mango groves in the study districts were planted by the ancestors of the present generations. Although exact dates of planting are not known, the tree age (with majority of trees being 60-70 years old as suggested by the respondents) provides a fare indication that these groves were planted somewhere in the decades of 1940s and 1950s. Some groves may have been raised later in 1960s and early 1970s. Some elder respondents (26%) indicated that besides the welcomed availability of fruits, the supposed environmental services provided by the trees also seems to have prompted their ancestors to raise mango groves in productive but uncultivated (due to absence of irrigation facilities) lands.

The mango groves were raised in almost every piece of uncultivated land in village periphery and consisted of a deliberate mix of landraces suited for different purposes (sucking and eating fresh, pickling and making other value-added products) and having different ripening times so as to stagger the harvest for a longer period of time. This selection scheme seems to have facilitated *in situ* conservation of diverse landraces exhibiting genetic variability and a range of desirable traits. The mango groves in the study districts are in fact genetic repositories of hundreds of unique landraces possessing one or more desirable horticultural traits. Unfortunately, this immense biodiversity is currently under threat. As stated by a majority (73%) of the respondents, in the last three decades there has been about a 30% reduction of lands under mango groves. Here, it is relevant to mention that the loss of even a single tree may amount to the extinction of a particular landrace. This alarming rate of reduction is worrisome and requires immediate interventions to promote the *in situ* conservation of these mango landraces and the livelihood they provide to local communities.

A recent study highlights the fast diminishing diversity of traditional crops and varieties in eastern Uttar Pradesh[5]. In neighbouring Varanasi district, the mango-growing area has been significantly reduced in the recent past, a problem attributed to rapid urbanization and apathy of growers towards scientific management of trees[18]. The farmers in tropical regions of the world have actively maintained trees as part of their agricultural landscapes. Trees provided shade, shelter, energy, food, fodder and many other goods and services for livelihood support[19]. The practical utility of *ex situ* conservation methods in germplasm conservation is rather limited. Such methods suffer from many drawbacks, such as inadequate sampling procedures during field collection and lack of representation in gene banks of the whole range of diversity of a given crop and its close genetic relatives. In this regard, *in situ* conservation would seem to be a sensible strategy for the maintenance and enhancement of crop landraces in traditional agroecosystems[20]. . The mango tree, its fruits and traditional products have been integral parts of local farming systems, food habits and local culture for generations. Notwithstanding the immense food and environmental value of these mango groves, their present state points to potential threats to their very existence.

Intergenerational gap in traditional knowledge

The results confirmed that there is an intergenerational gap with respect to traditional knowledge relating to various aspects of mango tree management and traditional products. In almost all cases, the younger participants exhibited a very low level of knowledge about mango varieties and agroecosystems as compared to middle and old aged respondents (**Fig. 2**). The fact that intergenerational erosion of biocultural knowledge was very high among the children and youth points to the influences of modernization, globalization and structural changes in the traditional society. Added to this, the disintegration of extended families into nuclear ones and the changing social milieu also seem to affect cultural values and intergenerational knowledge transmission. Given the current trends, it could be assumed that the present generation may be the last to retain any significant knowledge on mango landraces and traditional products, unless sustained efforts are made to sensitize them about the importance of mango trees in their lives.

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Table 1-Ingredients, methods of preparation and nutritive-ethnomedicinal properties of traditional mango products

Product	Ingredients	Method	Nutritive-ethnomedicinal properties
Achar	*Ajwain* (thyme), *methi* (fenugreek), *mirch* (red chilli powder), *hing* (asafoetida), *haldi* (turmeric powder), mustard oil and table salt.	Fruits are washed and dried under shade; cut into 4-8 pieces; turmeric powder and salt are added and the mixture is kept under sun for one day. Next day, about 10 g each of *ajwain*, *methi*, *mirch*, *hing*, *haldi* and table salt and 1 l of mustard oil are added to 1 kg fruit and the mixture is kept under sun for 2-3 days.	Rich in fibres, vitamins and minerals, it is a good appetizer; increases the palatability of food and stimulates the flow of gastric juice and thus improves digestion.
Sirka	Fermented sugarcane juice, *lahsun*, *panchforan*, *mirch* (red chilli), mustard oil and table salt.	1l fermented sugarcane juice is used for 1 kg fruit. The juice is boiled in fryer till half amount remains. In a separate fryer, condiments are fried with mustard oil for a few minutes. Now, mango slices are added and fried for a few more minutes. In next step, sugar cane juice and salt are added and boiled for about 10 minutes.	The nutritive properties of *sirka* are quite similar to those of *achar*. It, however, has relatively longer shelf-life (4 years) than *achar* (about 2 years).
Khatai	*Lahsun*, *haldi*, *dhaniya*, *mirch*, *hing*, *panchforan*, mustard oil and table salt.	Fruits are washed, dried and cut in half. The slices are dried under sun for 3-4 days. The dried slices are dipped in water and again dried under sun. Condiments, oil and salt are added and the mixture is kept under sun for a day.	*Khatai* is a popular ingredient in *arhar ki dal* in eastern Uttar Pradesh. It enhances the flavour of *dal* and is supposed to be rich in vitamin C. It is said to boost the digestion process.
Amchur	*Kalaunji masala*, *haldi*, *mirch*, *garlic paste*, mustard oil and table salt.	Fruits are washed, dried, cut in small pieces and dried under sun for 3-4 days. The dry pieces are now ground in *khal-batta* (traditional, iron grinder). The powder obtained is mixed with ingredients and stored for use.	Having very good shelf-life, *amchur* constitutes an intrinsic part of many traditional dishes. It is a significant source of antioxidants and dietary fibres.
Chutney	*Pudina* (mint), *lahsun* (garlic cloves), *mirch* (green chilli) and table salt.	Fruit pulp is mixed with ingredients and water and the mixture is grind. Only a little water is added to obtain a thick consistency.	Tangy and mouth watering, chutney is used with main course, particularly *dal-chawal*. It has coolant properties and improves the palatability of food.
Shakkar amba	*Haldi*, *mirch*, suagr, small cardamom and table salt.	Fruits are washed, dried and peeled for extracting the pulp. The pulp is grated and excess water is drained of by straining in white cloth. The pulp and	A traditional product quite similar to mango jam, but prepared without any preservatives. Eaten with *roti* and *parantha* in breakfast and

		sugar (in equal amounts) are cooked in fryer for few minutes. In next step, other ingredients are added and the product is ready for use.	with dal-chawal. Considered a ready source of energy, *shakkar amba* is a favourite of children.
Aam ka pana	*Pudina, kala namak, jeera* and water.	Roast the fruits on light fire for about 10 minutes. Alternatively, fruits can be boiled but roasted fruits give better quality. Pulp is extracted from the boiled fruits. The pulp is mixed with ingredients to prepare the refreshing drink.	A popular summer drink prepared in homes. It is cool, tangy and refreshing. Considered to be rich in vitamin C and minerals, it is a good remedy for dehydration and heat stroke. The sale of *aam ka pana* also provides livelihood to local vendors.
Amawat	Mustard oil, *mirch, lahsun and haldi*.	Fruit pulp is spread on white cloth. After the first layer dries, another layer is spread over it and allowed to dry under sun. The process is repeated for about 15 days until the desired thickness is reached. At end, the thick layer is separated from the cloth and a paste of ingredients is applied both the sides. Now, it is kept under sun for a day and stored for use.	Considered to be rich in vitamins A and C, vital minerals and energy. Constituted a major source of food as bowlful of *amawat* chutney was eaten with *roti* (bread) in monsoon and post monsoon months in recent past.
Galka	*Gud, mirch, jeera, mangrail, methi, lahsun, dhaniya, haldi*, mustard oil and table salt.	Fruits are washed and cut in small pieces. The ingredients (*jeera, mangrail, methi, lahsun*) are fried with mustard oil till light brown colour appears. In next step, fruits and condiments (*dhaniya*, *haldi* and salt) are added and fried for a few minutes till the fruit pulp is fully mixed with other ingredients. Now add *gud* and cook for a few more minutes. Cool down the product and store for use. This product keeps well only for 4-5 days.	A sweet tasting product, often eaten with bread and *parantha* in breakfast. Also used with main course. It is considered a ready source of energy.
Gulamma	*Gud*/sugar, wheat flour, *jeera* and mustard oil.	Fruits are washed and peeled. Take one table spoon mustard oil in fryer and add *jeera*. In next step, fry mangoes for about 15 minutes. Now add *gud*, roasted wheat flour and a little water and cook for a few minutes. Cool down the product and use in a day or two.	A sweet-sour tasting popular snack similar to *aonla murabba*. It is rich in fibres, vitamins and minerals. Its regular consumption strengthens the digestive system.

Fig. 1 Illustrations: a-traditional mango harvester (locally called *khota*), b-mango pieces being dried in traditional bamboo basket for *achar* preparation, c- prepared mango *achar* in glass jar, d-half cut mango fruits to be processed into *khatai*, e- amchur powder, and f-a local shop selling *aam ka pana*

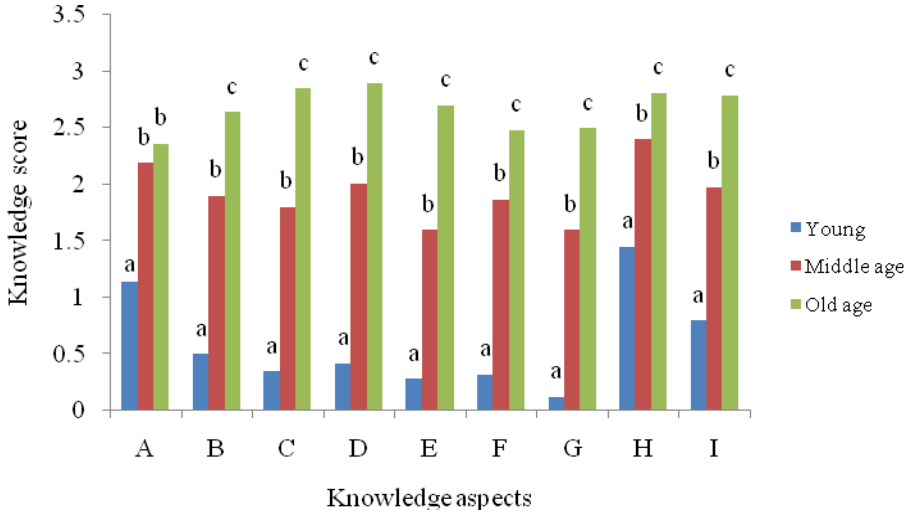

Fig. 2 The bars denoted with ‘a’, ‘b’ and ‘c’ indicate ‘Z’ test significance at 0.05 per cent probability level. Age profile: Young (n=12, 15-30 years), middle aged (n=12, 31-45 years), old aged (n=36, 46 years and above). Abbreviations, A= Variety, B= Traditional products, C= Flowering, D= Cultural significance, E= Food value, F= Emerging constraints, G= Management practices, H= Use of indigenous terms, I= Associated flora.